

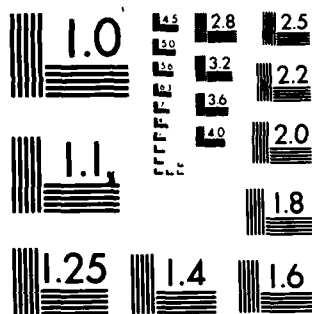
ARCHEOLOGICAL INVESTIGATIONS AT THE THREE RIVERS FLOOD  
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ARCHEOLOGICAL INVESTIGATIONS AT THE THREE  
RIVERS FLOOD CONTROL PROJECT: A FINAL REPORT

James R. Pliska

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The preparation of this document was accomplished under Contract No. DACW63-79-C-0157 with the U.S. Army Corps of Engineers, Fort Worth District, P.O. Box 17300, Fort Worth, Texas, 76102. This report does not necessarily constitute the final project concept to be adopted and approved by the U.S. Army Corps of Engineers.

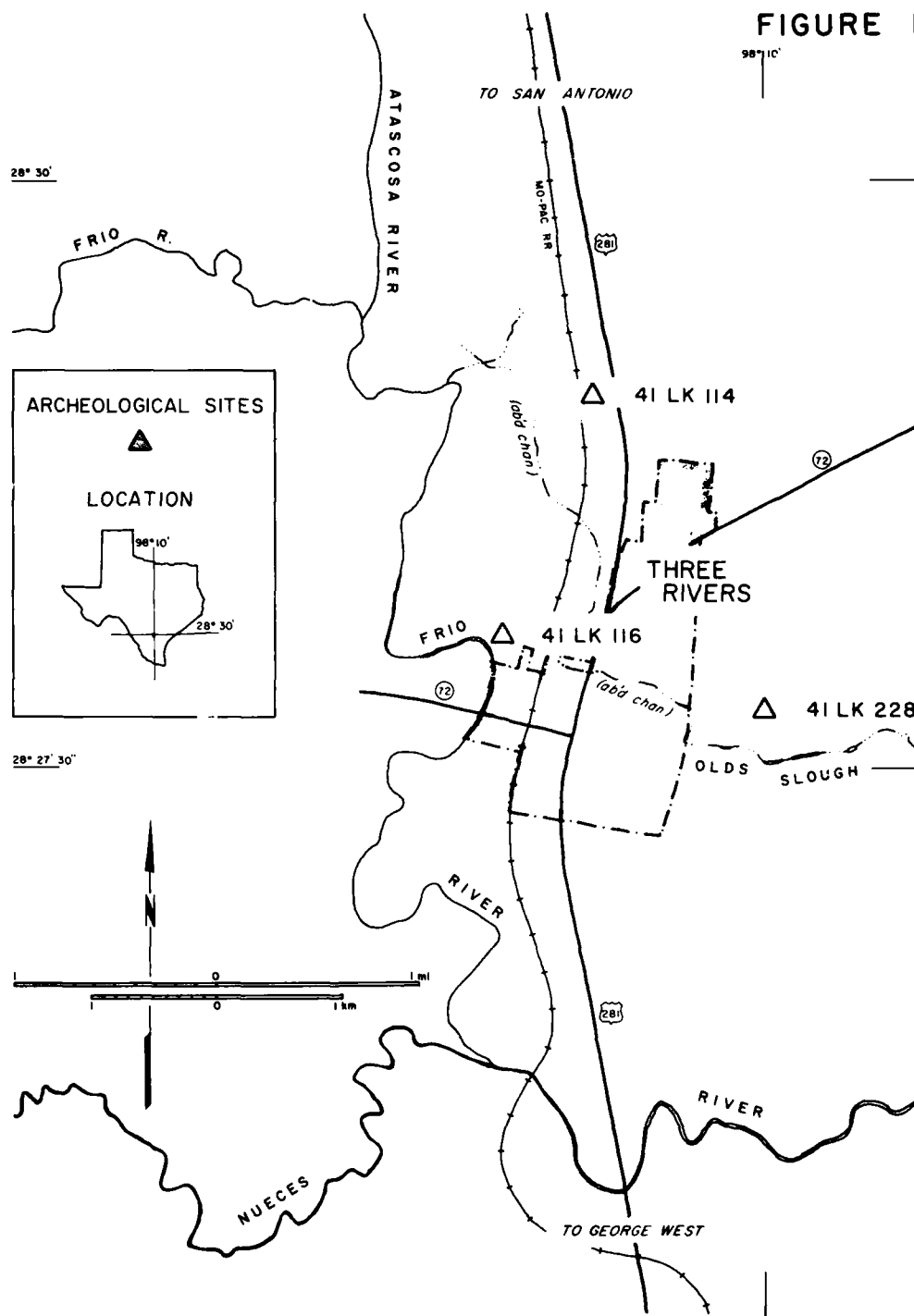
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FIGURE 1



LOCATION MAP -  
EXCAVATED SITES IN THE THREE RIVERS AREA,  
LIVE OAK COUNTY, TEXAS

# ARCHEOLOGICAL INVESTIGATIONS AT THE THREE RIVERS FLOOD CONTROL PROJECT: A FINAL REPORT

## INTRODUCTION

This report details the results of the final phase of archeological investigation of the proposed Three Rivers Flood Protection Project conducted by the Texas Archeological Survey for the Fort Worth District, U.S. Army Corps of Engineers, and represents the fifth in a series reporting on the effects of this project on definable cultural resources. The Three Rivers Flood Protection Project is a plan of improvement under which the city of Three Rivers will be protected from major flooding by the construction of a levee east of the Frio River. Initiated east of the city (near site 41LK228), the 4.6 mile long levee will extend northward to encircle three-fourths of the city, terminating at site 41LK114 (Fig. 1). The earthen fill for construction will be alluvial materials procured from selected barrow areas.

During the initial phase of archeological assessment in 1975, nine prehistoric sites were recorded by the field survey; six of these would have been adversely affected by the project construction as then designed (Mallouf 1975).

In 1977, alterations in the engineering design and levee placement necessitated additional surface survey and a reassessment of recommendations offered in 1975. Sites 41LK57, LK113 and LK114, located by the original survey,



and one newly recorded site, 41LK116, were evaluated as endangered and meriting test excavations (see Mallouf 1977).

Later that year, testing of sites 41LK57, LK113, and LK114 was completed by the Texas Archeological Survey. Of these three, only LK114 seemed to retain sufficient structural integrity to merit controlled subsurface sampling and to meet the criteria for nomination to the National Register of Historic Places (see Prewitt and Scott 1977).

In 1979, additional surface survey of the proposed borrow areas and of a high probability area near the southern terminus of the levee resulted in the recording of three prehistoric sites. The high probability area was designated as site 41LK228, and was recommended for subsurface sampling (Dibble 1979).

In September and October of 1979, final mitigation of sites 41LK114, LK116, and LK228 was carried out by Texas Archeological Survey staff members Molly B. Godwin, Gene P. Davis, and Mary Jane McReynolds, under the field supervision of James R. Pliska.

Original estimates suggested that work at the three sites could be accomplished in thirty calendar days by a crew of four. Unfortunately, a number of circumstances beyond the control of the excavators prevented the most efficient possible use of the allotted time.

At 41LK114, the landowner was unwilling to permit the use of power equipment. All excavations had to be carried out using hand tools, which effectively precluded the possibility of opening up extensive portions of the site in a single week. In addition, the property owner's agricultural schedule was such that the crew was actually permitted only four days on the site, including the time required to manually backfill those areas which had been excavated.

Work at 41LK116 was complicated by the discovery that the site was approximately four times the size indicated by earlier field investigations (Mallouf 1977). Naturally, this dramatically decreased the percent of the site area which could be excavated with the allotted time and personnel.

Investigations at 41LK228, like those at 41LK114, were hampered by the landowner's prohibition of power equipment. Another, and perhaps an even more serious problem was that the crew was restricted, by the property owner, to the eastern and most disturbed portion of the site. An earlier survey (Dibble 1979) indicated the presence of intact features and relatively heavy artifact concentrations in exactly those parts of the site from which the excavators were excluded.

Given these constraints of time and equipment, it was not possible to open up large segments of any of the

sites. Instead, test pits were placed in various parts of each site, and those units which appeared productive were excavated further.

### ENVIRONMENTAL SETTING

The Three Rivers project area is located in northern Live Oak County, Texas, in the Nueces River basin near the confluence of the Atascosa and Frio rivers with the Nueces (Fig. 1). The Atascosa joins the Frio about two miles northwest of the city; the Frio and Nueces converge two miles downstream, south of the city.

Topographically, the Three Rivers area is characterized by gently rolling land cut by the wide, flat floodplains of the rivers. The elevation ranges from 100 to 200 feet AMSL.

The project area lies within the Gulf Coastal Plain physiographic zone (Fenneman 1938). Three Rivers, which lies near the center of this belt-like region, has an annual precipitation of approximately 26 inches. The mean annual temperature is 70° F., indicating a fairly mild climate. The prevailing winds are southwesterly, and average about 8 miles per hour (U.S. Corps of Engineers 1975). Major climatic events are the result of hurricanes originating in the Gulf of Mexico.

### GEOLOGY

The study area lies within the central portion of

the Texas coastal plain, an erosional area of gently rolling topography broken only by cuerdas of the resistant Catahoula and Oakville deposits.

The geologic formations in Live Oak County are of Eocene to Holocene age. Rocks in these formations are sedimentary in origin, the results of major depositional events brought about by structural changes and by subsidence of the coastal plain.

The Eocene is represented in Live Oak County by the interbedded sands, muds and impure lignite of the Jackson Group (Eargle, Hinds and Weeks 1973). These are overlain by the Oligocene Fayette and Frio Clays, upon which the Catahoula Formation rests unconformably.

The Catahoula Formation is composed of deposits from the Gueydan fluvial system of the Rio Grande Embayment (Galloway, Finley and Henry 1979). Tuff, clay, tuffaceous sand, tuffaceous clay, and conglomerate beds rich in chert, chalcedony, opal and quartzite make up the Catahoula of South Texas.

Next in the geologic evolution of South Texas was the deposition, during the Miocene, of the Oakville and the subsequent Fleming/Lagarto formations. The overlying Goliad Formation was deposited during the Pliocene, as were the quartzite, jasper and chert-rich Uvalde gravels.

In Pleistocene to Holocene times, valley incision

and the topographic modifications caused by sea level fluctuations have combined to create the existing coastal plain topography.

At the Three Rivers sites, the Catahoula tuff forms the basal unit; the outcropping formations are of recent alluvium. The area contains an abundance of lithic materials appropriate for aboriginal exploitation. The Uvalde gravels occur along hilltops and ridges; cobbles of Catahoula cherts and chalcedonys occur as gravel deposits along the stream channels and terraces of the Frio River.

#### SOILS

The Oakville Formation and the underlying Catahoula Formation form the rolling topography along the Frio River valley. Both include pyroclastics (tuffs, volcanic ash and bentonitic clays), sediments which have had a great impact on the pedogenic processes. In the arid to semiarid climate of the study area, weathering of this type of parent material produces montmorillonite, a major clay constituent of the soils of the area, and also results in the precipitation of calcium carbonate nodules (Galloway, Finley and Henry 1979). The soils in the study area are generally level to undulating, moderately deep, calcareous, and loamy to clayey in texture.

## FLORA

Inglis (1964) described this portion of South Texas as the Rio Grande Plain. It is included by Blair (1950) in the Tamaulipan biotic province, and described by him as a savannah of grasses and mesquite. Tharp (1939) characterizes the area as a mesquite-chapparral region. Blair's description best approximates the area of the Three Rivers project.

The Tamaulipan province is dominated by thorny brushland, although live oak (*Quercus virginiana*) is often found in stands on the floodplains. The dominant brush vegetation is characterized by mesquite (*Prosopis juliflora*), *Acacia*, *Mimosa*, granjeno (*Celtis pallida*), lignum vitae (*Porlieria augustifolia*), cenizo (*Leucophyllum texanum*), white brush (*Aloysia texana*), prickly pear (*Opuntia lindheimeri*), tasajillo (*Opuntia leptocaulis*), *Condalia* and *Castela*. Clay-based soils usually support all of these species, while on sandy soils, open stands of mesquite surrounded by various grasses are more typical (Blair 1950). Before land management practices, and especially overgrazing, altered the plant community, dominant grasses included Arizona cottontop, buffalograss, curly mesquite, longspike silver bluestem, and species of *Setaria*, *Pappophorum*, and *Bouteloua* (U.S. Corps of Engineers 1975).

The Three Rivers area contains, in addition, a number of species other than those considered to dominate the entire

Tamaulipan province. A small vegetation sample, collected along the Frio River during the 1975 archeological survey, yielded the following items: ash, mulberry, hackberry, mesquite, chinaberry, oak, turk's cap, pidgeon berry, wooly bucket, camphor weed, dewberry, morning glory, mustang grape vine, sedge, bristle grass, Spanish moss, frog fruit, ruellia, green briar, pannic grass, tickle tongue and sump weed (Mallouf 1975).

#### FAUNA

The regional fauna of the Tamaulipan province includes, or has recently included, at least sixty-one species of mammal, thirty-six snakes, nineteen lizards, two land turtles, three urodeles and nineteen anurans (Blair 1950). The major mammals of the area, which were probably exploited by the aboriginal occupants, include the opossum, shrew, mole, armadillo, jack-rabbit, cottontail, fox squirrel, ground squirrel, pocket gopher, various species of rat and mouse, gray wolf, coyote, black bear, ringtail, raccoon, coati, weasel, badger, skunk, cougar, bobcat, javelina, and whitetail deer (Blair 1952: 236-247). Major native fowl are the mourning and white-winged dove, quail and wild turkey (Blair 1950, 1952).

#### ARCHEOLOGICAL BACKGROUND

A general culture history and chronology for South

Texas has been established, and is summarized in works such as Hester and Hill (1975), Hester (1976) and Hester (1977). Until recently, however, there was very little professional archeological research within Live Oak County itself.

A generalized temporal schema employed for South Texas is composed of four cultural stages: Paleoindian (pre-10,000-8,000 B.P.), Archaic (8,000-800 B.P.), Late Prehistoric (800 B.P. to European contact) and Historic. These stages have been defined on the bases of subsistence strategy and artifactual and geographic associations.

The Paleoindian Period is the earliest cultural stage recognized in South Texas. It is generally considered as a big game oriented hunting tradition for which the late Pleistocene megafauna provided a substantial portion of the subsistence base. The 8,000 B.P. terminal date for the period corresponds approximately to the time of significant post-Pleistocene extinctions. The major time-diagnostic artifacts of the period are lithic, especially projectile points such as the *Clovis*, *Folsom*, *Scottsbluff*, *Plainview*, *Meserve* and *San Patrice* types.

The Archaic Period economy was based on more diversified hunting and gathering. A variety of diagnostic lithic assemblages, as well as cultural features such as hearths, burials, pits, trash middens and burned rock concentrations, are typically associated with the known archeological record



of the Archaic.

The Late Prehistoric Period is marked by technological innovations such as bone-tempered ceramics and the bow and arrow. Considerable variation exists in the lithic and ceramic assemblages of the period.

The Historic Period is considered to start after European contact, and may include the remains of either indigenous or intrusive cultures.

Organized archeological research in Live Oak County began in 1967 when W. H. Wakefield of the Texas Archeological Salvage Project, The University of Texas at Austin, reported on eighteen sites located during a survey of the proposed Choke Canyon Reservoir (Wakefield 1968). Paleoindian and Archaic materials were recognized at that time. Seven years later, Sorrow, O'Malley and Fox (1974) of the Texas Historical Commission reported upon further reconnaissance in the same area. Their survey recorded 129 sites of Archaic, Late Prehistoric, and Historic age. In 1977, further survey of the Choke Canyon Reservoir was completed by the Texas Historical Commission (Lynn, O'Malley and Fox 1977), bringing the total number of recorded sites in the project area to 161. The cultural material reported was representative of the Paleoindian to Late Prehistoric periods. Recently, the Center for Archaeological Research, The University of Texas at San Antonio, has been investigating Paleoindian through Historic remains

in the Choke Canyon area for the Bureau of Reclamation's Nueces River Project (Hall 1980). In excess of 400 sites have been identified by that project, and somewhat less than 10 percent of those merited further investigation. Intensive excavations are projected for five of the identified sites.

Archeologists from the State Department of Highways and Public Transportation are currently analyzing artifactual material recovered from excavations at site 41LK28, an occupation and cemetery site containing over 160 burials. The analysis of these materials is expected to shed new light on Archaic life styles and burial patterns (Johnson 1980).

Limited excavations were carried out by the Center for Archaeological Research, The University of Texas at San Antonio, at 41LK106, a prehistoric site on Sulphur Creek. Artifacts recovered suggest Middle to Late Archaic and Late Prehistoric occupations (Creel *et al.* 1979).

Archeological assessments in the Three Rivers Flood Protection Project area were initiated in 1975 by the Texas Archeological Survey. The first survey located one historic and nine prehistoric sites (Mallouf 1975). In 1977, changes in the design of the proposed levee necessitated additional archeological coverage. Three prehistoric sites and one multi-component (historic and prehistoric) site were recorded (Mallouf 1977). Later that same year a testing operation

was carried out by TAS at sites 41LK57, LK113 and LK114 (Prewitt and Scott 1977). In 1979, field investigation of two proposed borrow areas and the southern terminus of the levee yielded three additional sites (Dibble 1979). The final mitigation of sites 41LK114, LK116 and LK228 reported herein resulted from recommendations derived from these previous assessments of the project area.

#### METHODOLOGY

The excavation plan at sites 41LK114, LK116 and LK228 followed essentially the same format. At each site, an arbitrary Cartesian (x and y) grid was established by transit to provide horizontal control. The grids were aligned to magnetic north, with grid coordinates increasing to the north and west from a zero coordinate, defined as N100/W100 at 41LK114, and as N1000/W1000 at 41LK116 and LK228. Each excavation unit is designated by the coordinates of its southeast corner.

Vertical control was based upon the excavation of 10 or 20 cm. arbitrary levels, maintained by below-surface elevations measured from the southeast stake of each unit. Datum was established designating the surface level at the zero coordinate stake as 100 meters.

Unit levels were excavated by hand, using trowels and shovels. The matrix from each unit was dry screened

Figure 2.

a. General view of 41LK114

b. General view of 41LK116

c. General view of 41LK228

FIGURE 2



through  $\frac{1}{4}$ " wire mesh. All material recovered in the screens was collected, with the exception of some calcium carbonate nodules. Collected material was placed in bags labeled to indicate provenience by unit and level. At the conclusion of each excavation level, a General Record Form was filled out, noting matrix characteristics, observed cultural material, and other pertinent information. The recording system also included profile drawings, and photographs of the soil matrix at each site.

All records and archeological material collected during the course of these excavations are housed at the Texas Archeological Research Laboratory, The University of Texas at Austin.

Three 1 x 2 and one 1 x 1 meter units were excavated at 41LK114. At 41LK116, four 1 x 2 meter units and two 50 x 50 cm. test pits were excavated. Since power equipment was permitted at this site, it was also possible to dig four backhoe trenches which were helpful in determining the extent of the cultural deposits and the nature of the soil deposition. Excavations at 41LK228 included four 1 x 2 and two 1 x 1 meter units. The site maps (Figs. 3, 6 and 8) indicate precise unit and trench locations.

## SITE DESCRIPTIONS

## 41LK114

Site 41LK114 is approximately 0.5 mile north of the city of Three Rivers and 0.25 mile west of U.S. Highway 281 (Fig. 1). The site is in a recently plowed field on a high terrace knoll overlooking a tributary of Hackberry Creek approximately 0.5 mile east of the confluence of Hackberry Creek and the Frio River (Fig. 2a). At the time the work was performed, the field was planted in a hay fodder cultigen which, being approximately waist high, obscured surface visibility. Fences border the field on all sides, and it is bounded on the west (downslope) side by the Missouri Pacific Railroad tracks. The cultural material is approximately 60 x 60 meters in extent (Fig. 3).

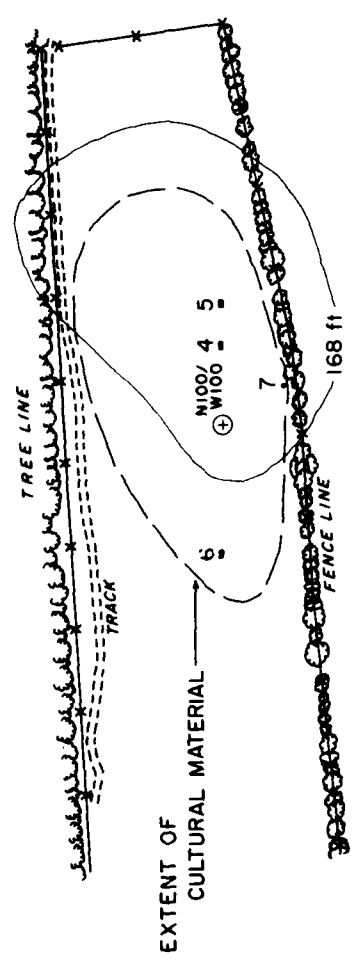
The site lies in alluvial sediments overlying a Pleistocene terrace remnant of compact, red-brown, mottled clay. This older alluvial terrace remnant was encountered only in Unit 7 (N85/W100). The other units contained sandy clay soils forming from recent Holocene alluvium. Unmodified stream rounded pebbles and colluvial lag cobbles are present in the soil matrix, in frequencies which increase downslope from Units 4 and 5 toward Unit 6.

Three 1 x 2 and one 1 x 1 meter units were hand excavated; Unit 4 (N100/W100), Unit 5 (N100/W70), Unit 6

FIGURE 3

N

20 m



EXCAVATION UNIT •  
GRID CENTER ⊕

SITE PLAN MAP - SITE 41 LK 114  
Three Rivers: 1979



(N100/W130) and Unit 7 (N85/W100).

#### UNIT 4

The location of this unit was selected largely on the basis of a noticeable surficial concentration of burned and fire-cracked rock in this portion of the site. Such concentrations may reflect subsurface strata, or may be indicative of relatively intact hearths beneath.

Unit 4 contained culturally and nonculturally introduced stream-worn gravels within a matrix of brown, calcareous sandy clay. This matrix exhibits characteristics of a Fluventic Ustochrept, a subgroup of the Inceptisol order (Fig. 4). These soil types are formed in alluvium on low terraces in subhumid to semiarid regions (U.S.D.A. 1975). Root and rodent disturbances were observed at all levels and contributed to the mixing of the culturally introduced material and the soil matrix.

Initially, 10 cm. vertical levels were excavated. Beginning with Level 6 (50-70 cm. b.s.), the levels were increased to 20 vertical cm. and the horizontal extent of the unit was reduced from 1 x 2 to 1 x 1 meters. Excavation continued to 150 cm. below the surface. Cultural material was encountered at all levels within the sandy clay matrix; no features or major artifact concentrations were located.

Figure 4. Soil profile at 41LK114

- A<sub>p</sub> 0 to 15 cm., dark brown (7.5YR3/2)  
dry sandy loam; weak fine and  
medium granular structure; loose;  
many roots; abrupt wavy boundary;  
strongly alkaline (8.9)
- A<sub>1</sub> 15 to 50 cm., dark brown (7.5YR5/3)  
dry sandy clay loam; subangular  
blocky structure; hard (dry);  
friable (moist); some roots;  
few fine CaCO<sub>3</sub> concretions
- AC 50 to 90 cm.; brown (10YR5/3) with  
mottles of very pale brown (10YR7/3)  
dry sandy clay loam; increase in  
CaCO<sub>3</sub> concretions
- C 90 to 150 cm.; light yellow brown  
10YR6/4) sandy clay; extremely  
hard, very firm; calcareous;  
strongly alkaline



### Cultural Material

Lithic artifacts recovered were four dart points (Fig. 5), one thin biface fragment, and seventeen utilized flakes or chips.

#### Dart Points

Specimen A (Fig. 5a): *Bulverde*-like (Suhm and Jelks 1962: 169); long, straight-sided, triangular blade; prominent shoulders; straight stem with a slightly rounded almost straight base. The specimen exhibits thermal alteration. Provenience 30-40 cm. below surface.

Length: 3.8 cm. Width: 1.7 cm. Stem Width: 0.8 cm.

Specimen B (Fig. 5b): *Tortugas*-like (Suhm and Jelks 1962: 249); triangular shape; basal thinning; irregular lateral edges; slightly convex and narrowing to the distal point which has been broken. Provenience 0-10 cm. b.s.

Length: Undetermined due to breakage Width: 2.3 cm.

Specimen C (Fig. 5c): Unidentified type; the specimen appears to be reworked; crude triangular blade, irregular slightly convex edges; one weakly barbed shoulder; weakly parallel, almost uneven stem sides; convex to rounded base. Provenience 30-40 cm. b.s.

Length: 3.0 cm. Width: 1.2 cm. Stem Width: 0.85 cm.

Figure 5. Artifacts from 41LK114

- a. *Bulverde*-like dart point (Unit 4)
- b. *Tortugas*-like dart point (Unit 4)
- c. Unclassified dart point (Unit 4)
- d. *Darł*-like dart point (Unit 4)
- e. Quartzite oval hammerstone (Unit 7)
- f. Examples of flakes by group

FIGURE 5



Feature 1 41LK116  
A concentration of burned rock  
burned clay, and burned sand-  
stone exposed in the east wall  
of backhoe trench 4.



a



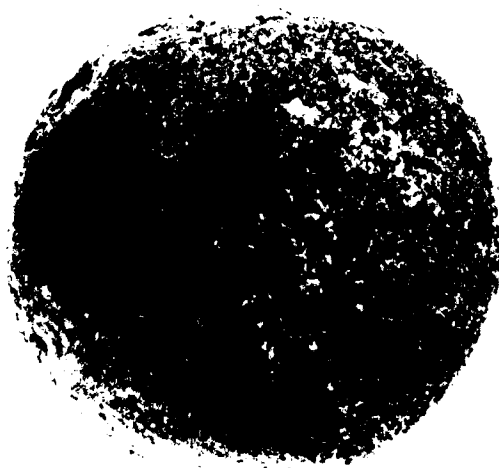
b



c



d



e



Group I



Group II



Group III



Group IV

f

Specimen D (Fig. 5d): *Dar1*-like (Suhm and Jelks 1962: 179); thick, irregular, slightly convex sides; one weak and one extremely weak shoulder; straight sided stem; slightly convex base.

Provenience 30-40 cm. b.s.

#### Biface fragment

One thin distal biface fragment less than 2 cm. thick was recovered from 70-90 cm. b.s.

#### Utilized flakes and chips

Utilized flakes and chips were categorized as primary, secondary or tertiary according to the extent of decortication. These groups were subdivided into four categories differentiated by the location (in relation to the platform or percussion bulb) where utilization (use wear and/or retouch) was evident. Examples are presented in Figure 5f.

Group I: Specimen exhibits utilization on one lateral edge. 2 tertiary and 2 secondary specimens.

Group II: Specimen exhibits utilization on both lateral edges. 1 tertiary and 1 secondary specimen.

Group III: Specimen exhibits utilization on distal end. 2 tertiary and 1 secondary specimens.

Group IV: Specimen exhibits utilization on one or both lateral edges and the distal end. 6 tertiary and 2 secondary specimens.

Other cultural material recovered includes burned rock,

burned clay, cores, lithic debitage, and fragments of petrified wood and sandstone. The frequency or weight of this cultural debris is presented by site, unit and subsurface level in tabular form in Appendix I.

#### Faunal Remains

Six unidentifiable bone fragments were recovered from Unit 4 (see Appendix I).

#### Shell Remains

Terrestrial snails and freshwater mussels were collected. Complete shells and shell hinges were catalogued by weight and number and are listed in Appendix I. The most common snails are *Polygyra* and *Rabdoma*; the mussel which prevails is *Unio merus tetralasmus*.

#### UNIT 5 (N100/W70)

The unit was placed on the crest of the knoll in an attempt to define the nature and extent of the cultural deposits in the area. An elevated area such as this was considered as a probable locus of high density aboriginal activity.

This 1 x 2 meter unit was excavated to 80 cm. below the surface. The soil matrix was similar to that of Unit 4 in color and structure except for a decrease in the amount of gravel. This is a result of past fluvial processes in which the heavier bedload was deposited along the flank of the terrace, decreasing near the higher elevations.

### Cultural Material

Culturally introduced material was recovered from all levels of this unit. No features or noticeable concentrations of artifacts were encountered. Again the cultural deposits appeared altered by bioturbation.

No time-diagnostic artifacts were recovered. Only two utilized flakes were noted; one secondary Group IV and one tertiary Group II. See Appendix I for a listing of cultural materials and their provenience.

### Faunal Remains

Eight bone fragments were recovered from Unit 5. The four identifiable specimens are a possible rodent tibia (*Neotoma* sp.) and two pelvic fragments and a right calcaneum of a cottontail rabbit (*Sylvilagus floridanus*) recovered from the same level (20-30 cm. b.s.).

### Shell Remains

The shell remains are similar to those described for Unit 4.

### UNIT 6 (N100/W130)

Unit 6 was situated on the midslope portion of the site, in order to define the nature and extent of the cultural deposits on the slope. The fluvial deposition of sediments might have protected intact features or provided stratigraphic separation in this area.



Unit 6, a 1 x 2 meter unit, was excavated to 60 cm. below the surface midslope in the site area. The soil matrix was sandier with a higher frequency of stream-worn gravels and less lag cobbles. The soil was much coarser in texture and much less cohesive than that found upslope. This results from deposition of the coarser material while the suspended load was carried away by receding floodwaters.

#### Cultural Material

Although cultural material was recovered from all levels of this unit, the amounts were significantly lower than at either Unit 4 or Unit 5. The only increase was in the nonculturally introduced gravels and lag cobbles. No features or artifact concentrations were encountered. One utilized Group IV tertiary flake was recovered.

#### Faunal Remains

The seven bone fragments recovered from Unit 6 are too fragmentary to identify.

#### Shell Remains

No significant molluscan remains were recovered from Unit 6, and no terrestrial snails were present. The absence of terrestrial snails, usually attracted to the organic remains at human habitations, may reflect an extremely limited period of residence at this portion of the site. In view of the midslope location of Unit 6, it is also possible that the cultural material was deposited by slope

erosional rather than cultural processes. If the major use areas of the site were those at higher elevations, the lack of molluscan remains at Unit 6 may thus be explained.

#### UNIT 7 (N85/W100)

This area was selected for excavation because it is in a relatively undisturbed portion of the site, close enough to the fenceline to have avoided the worst effects of plowing. It was hoped that an intact feature or artifact concentration might thus be encountered.

While testing this area, Prewitt and Scott (1977) encountered a Pleistocene terrace remnant of brown-red mottled clay less than 30 cm. below the surface. This strata was encountered in Unit 7 at 35 cm. below the surface, and was color coded at 5YR 4/3 (Munsell Products 1973).

#### Cultural Material

No features or artifact concentrations were located in Unit 7. A single oval hammerstone was recovered 20 to 40 cm. below the surface. It is a quartzite cobble with a battered surface and wear predominantly along its edges (Fig. 5e).

#### Faunal Remains

No faunal material was recovered from Unit 7.

#### Shell Remains

None were recovered from Unit 7.

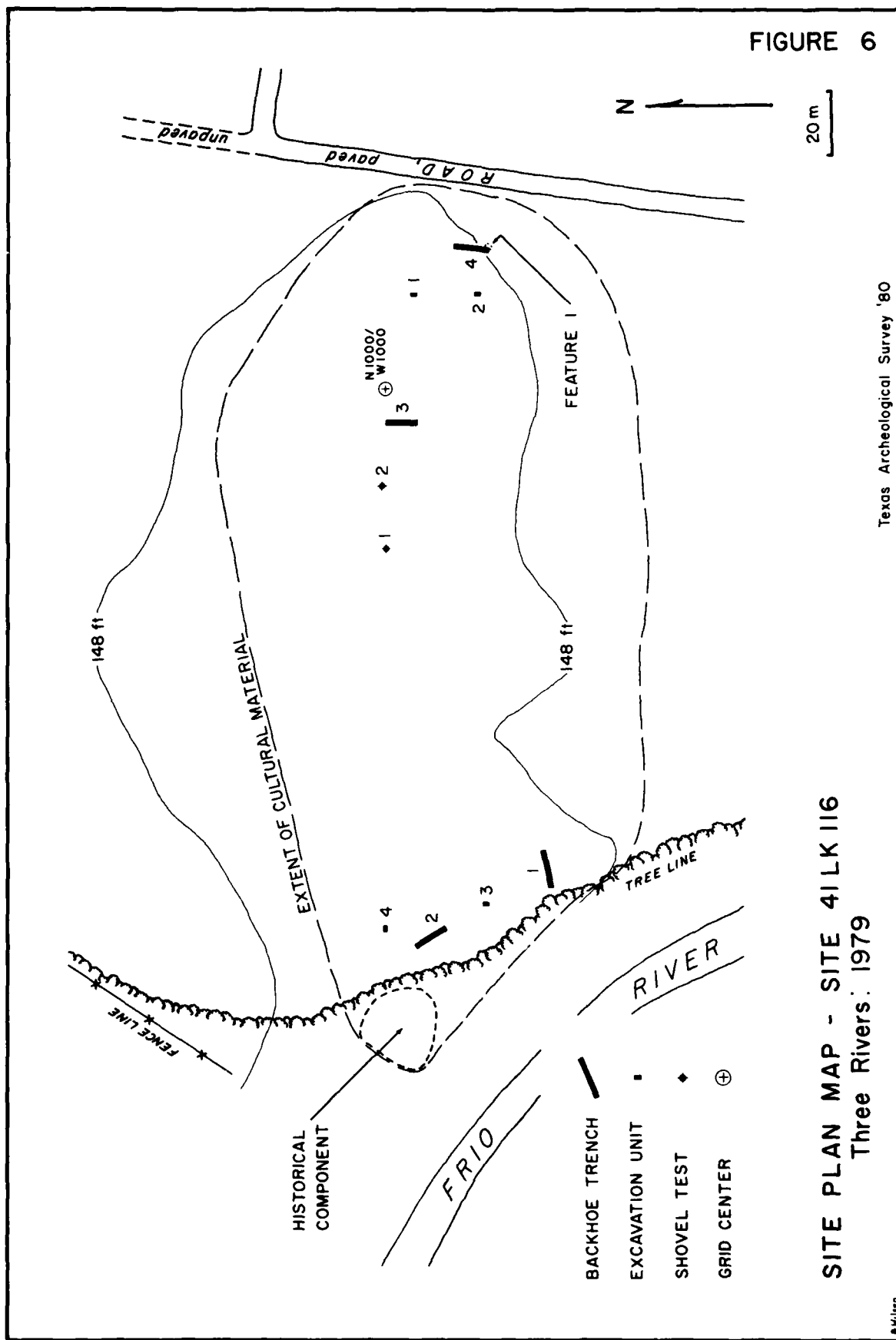
## 41LK116

During the initial survey (Mallouf 1977), this site was calculated to be 150 x 50 meters in extent. Before the placement and excavation of units was begun, crew members made a surficial inspection of the site, walking straight line transects and exploring the entire field. In areas where cultural material was encountered, flagging tape was used to delineate the site area and denote possible major surface concentrations of cultural material. Based upon this procedure, the site dimensions were recalculated at 250 x 120 meters, an area four times the size originally estimated (Fig. 2b).

Within the site limits, two major surficial concentrations were noted. One consisted of the western portion of the site, near the paved road (Fig. 6). Units 1 and 2 were placed in this area to test its subsurface components. The second major surficial concentration of material is along the eastern margin of the site, adjacent to the Frio River. Units 3 and 4 were located there.

The archeological excavations at 41LK116 consisted of four 1 x 2 meter test units and four backhoe trenches. The trenches were used to establish the nature and extent of cultural debris and the character of the soil matrix. In this part of the Frio River floodplain, the dominant soil type is a Typic Pellustert Vertisol formed by the effects of climate

FIGURE 6



SITE PLAN MAP - SITE 41LK116  
Three Rivers, 1979

and frequent wetting on the montmorillonitic clay alluvium deposited by overbank flooding (Fig. 7).

One wall of each backhoe trench was troweled clean and recorded as a profile drawing. During work on the eastern wall of backhoe trench 4, several chunks of burned clay were noted in the southeast corner, 22 cm. below the surface and directly below the plow zone. This concentration of burned clay was exposed, and was designated Feature 1.

#### Feature 1 (Fig. 5)

This concentration of burned rock, burned sandstone, rounded chunks of burned clay and a burned flint cobble covered a horizontal area roughly 20 x 26 cm., and ranged from 22 to 28 cm. below the surface. The concentration appeared to be a hearth remnant, mixed vertically and horizontally by the shrink/swell characteristics of the Vertisol soil matrix.

Associations: two unburned freshwater mussel hinges and a primary flake, as well as several small flecks of charcoal, were recovered from within Feature 1.

#### UNIT 1 (N990/W970)

A 1 x 2 meter unit was excavated in a location which exhibited a concentration of surface materials. Cultural material was present throughout the 40 cm. of soil excavated, but no features or artifact concentrations were noted.

### Cultural Material

Lithic artifacts recovered include two tertiary Group I utilized flakes and two thin biface fragments. The basal half of one biface fragment suggests a subtriangular shape with a thinned convex base, and exhibits some secondary retouch. The second biface is extremely fragmentary. Other cultural debris is listed by unit and level in Appendix I.

### Faunal Remains

No faunal remains were recovered from Unit 1.

### Shell Remains

Freshwater mussel was abundant in this unit (see Appendix I). Snails were present.

### UNIT 2 (N970/W970)

A 1 x 2 meter unit was excavated in a location which exhibited a concentration of surface materials. This unit was excavated to 40 cm. below the surface. At that depth, due to declining artifact density, the unit was reduced to 1 x 1 meters and excavated a further 20 cm. Rodent disturbance was apparent throughout the unit.

### Cultural Material

No features or artifact concentrations were encountered. Two tertiary Group I and one secondary Group I utilized flakes were recovered.

#### Faunal Remains

None were recovered from Unit 2.

#### Shell Remains

Freshwater mussel shell was present but less abundant than in Unit 1.

#### UNIT 3 (N968/W1164)

This 1 x 2 meter unit was excavated to determine the nature and depth of cultural material adjacent to the Frio River. An area with a high surface density of archeological material was selected and excavated to a depth of 40 cm. At the 20 to 40 cm. level, the unit was reduced to 1 x 1 meters. Cultural material was present in both levels, but artifact density decreased with depth. The soil matrix exhibited the same characteristics as that of the two previously excavated units.

#### Cultural Material

No cultural features or artifact concentrations were observed. Artifacts recovered include five prehistoric sherds, and three tertiary Group I, one secondary Group I, one tertiary Group III and one tertiary Group IV utilized flakes or chips.

The five sherds were located in the plow zone. They are small (less than 2 cm. in largest dimension) fragments of a sandy paste ceramic with bone tempering, gray core, and

Figure 7. Soil profile at 41LK116

- A<sub>p</sub> 0 to 20 cm.; light brown gray (10YR6/2) clay loam; subangular blocky structure; hard, firm, sticky, and plastic; numerous roots; abrupt wavy boundary; CaCO<sub>3</sub> concretions; shell fragments; slightly alkaline (7.9)
- A<sub>1</sub> 20 to 120 cm.; gray (10YR5/1) clay; some fine yellowish brown mottles; medium angular blocky structure; extremely hard (dry), very firm (moist); CaCO<sub>3</sub> nodules; shell fragments; slightly alkaline (8.0). (This zone could be broken down into A<sub>12</sub> and/or A<sub>13</sub> if more analyses were done)
- AC 120 to 190 cm.; gray brown (2.5YR5/2); faint brown mottles; characteristics same as above except masses of CaCO<sub>3</sub>
- C 190 to bottom of trench; dark grayish brown (2.5YR4/2) clay with many brownish yellow (10YR6/6) mottles; extremely hard (dry); common CaCO<sub>3</sub> nodules and soft masses





exterior color ranging from orange to light brown. These sherds may be from the same vessel but the edges are too worn to piece together.

#### Faunal Remains

The two bone fragments recovered from this unit are too small to identify.

#### Shell Remains

Mussel shell was present but this unit contained less than any of the units excavated at LK116.

#### UNIT 4 (N1000/W1173)

This unit was placed near the Frio River in hopes of recovering a larger, more diagnostic ceramic sample. Unit 4 was a 1 x 2 meter unit excavated to 80 cm. below the surface. At level 3 (40-60 cm. b.s.) the unit was decreased to 1 x 1 meters and at level 4 (60-80 cm.) to 1 x .60 meters. The soil matrix was slightly sandier and lighter in color than in previously excavated units.

#### Cultural Material

No cultural features or artifact concentrations were observed. The lithic artifacts recovered include two thin biface fragments and a thick biface. The latter is elliptical in outline, plano-convex in cross section, and has sinuous edges. The dorsal surface retains some cortex, and the ventral side is slightly concave due to fracturing. Of the

thin biface fragments, one is a crudely shaped distal portion; the other is a basal fragment with thinning along the base and secondary retouch along one edge. Both are so fragmentary that their general shape cannot be determined.

#### Faunal Remains

None were encountered during Unit 4 excavation.

#### Shell Remains

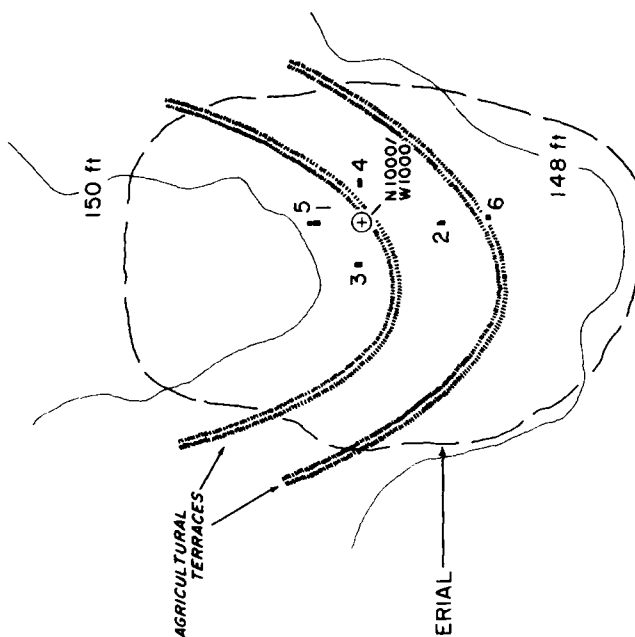
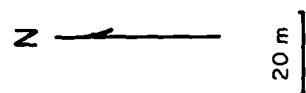
More mussel shell was recovered in this unit than in Unit 3, but significantly less than in Units 1 or 2.

### 41LK228

Site 41LK228 is located approximately 0.5 mile east of Three Rivers (Fig. 1) on a sandy clay loam terrace knoll overlooking the channel of Olds Slough. The immediate site area has been plowed and numerous sections have been severely modified by construction of artificial terraces (Fig. 8). At the time of excavation the field had been harvested and the surface visibility was good (Fig. 2c).

The site lies in alluvial sediments deposited by over-bank flooding of Olds Slough, an abandoned channel of the Frio River. The alluvial deposition and major soil forming factors (*i.e.*, climate, topographic relief) have produced soils similar to those at 41LK114. The soil matrix (Fig. 9) exhibits characteristics of a Fluventic Ustochrept, a subgroup of the Inceptisol order (U.S.D.A. 1975). The soil matrix at

FIGURE 8



EXCAVATION UNIT •  
GRID CENTER ⊕

SITE PLAN MAP - SITE 41LK228  
Three Rivers, 1979

Figure 9. Soil profile at 41LK228

- A<sub>p</sub> 0 to 20 cm.; dark gray brown (10YR4/2) dry sandy clay loam; medium granular structure; loose; many roots; few CaCO<sub>3</sub> concretions; abrupt wavy boundary; slightly alkaline (7.9)
- A<sub>1</sub> 20 to 45 cm.; dark gray brown (10YR4/2) dry sandy clay loam; subangular blocky structure; hard (dry), friable (moist); some roots; numerous CaCO<sub>3</sub> concretions
- AC 45 to 65 cm.; light gray brown (10YR6/2) dry sandy clay loam; increase in CaCO<sub>3</sub> concretions
- C 65 to 100 cm.; very pale brown (10YR7/3) dry sandy clay loam; hard, firm, calcareous; medium alkaline (8.3)



41LK228 is slightly shallower and contains greater concentrations of carbonates than does LK114. Rodent and root disturbances were present in all levels excavated and probably contributed to mixing of the cultural materials.

Prehistoric cultural material is distributed over an area approximately 100 x 120 meters (Fig. 8). A historic component consisting of earthenware and glass sherds, metal fragments and square nails is attributable to oil well drilling operations conducted during the early 1900's. The landowner stated that a drilling rig crew camped in the area about 80 years ago.

Excavations at 41LK228 consisted of four 1 x 2 meter and two 1 x 1 meter units. These units were restricted to the eastern flank of the site at the request of the landowner. Previous survey had described intact hearth remains and a heavier concentration of artifactual material at the crest of the knoll (Dibble 1979). Therefore, the units described below cannot be considered representative of, or to have fully explored the potential for, archeological recovery at 41LK228.

#### UNIT 1 (N1010/W1000)

Unit 1, a 1 x 2 meter unit, was excavated to a depth of 80 cm. This initial unit was placed where a concentration of material was surficially visible. The soil matrix was a

sandy clay loam (Fig. 9). Rodent disturbances were noted in every level.

#### Cultural Material

No features or artifact concentrations were observed. Lithic artifacts recovered include two abrading stones, one thick biface basal fragment and one thin biface distal fragment. The eight utilized flakes can be categorized as two tertiary and one secondary Group I, two tertiary Group II, one tertiary and one secondary Group III and one tertiary and one secondary Group IV.

One abrading stone is almost an equilateral triangle; the sides range from 2.0 to 2.5 cm. in length. Only one side shows abrasion. The material is a dense sandstone. The other abrader is a crude triangle of white tuffaceous sandstone. Two parallel, rounded channels approximately 7 cm. wide and 5 cm. deep are worn into the longest side of the specimen.

Burned rock, burned clay and other cultural debris recovered are listed in Appendix I.

#### Faunal Remains

Only one of 16 bone fragments recovered is identifiable - the distal portion of a right humerus of white tail deer (*Odocoileus virginianus*).

#### Shell Remains

Mussel shell and terrestrial snails are listed in Appendix I.

## UNIT 2 (N980/W1000)

Unit 2, a 1 x 2 meter unit, was excavated to a depth of 100 cm. The soil matrix was similar to Unit 1 with an increased frequency of rodent and root disturbances.

## Cultural Material

No features or artifact concentrations were encountered. Eleven utilized flakes consisted of four tertiary and one secondary Group I, two tertiary Group II, one tertiary Group III and three secondary Group IV.

## Faunal Remains

The eight bone fragments recovered were unidentifiable.

## Shell Remains

The quantity of shell recovered is similar to Unit 1.

## UNIT 3 (N1000/W1010)

Unit 3, a 1 x 2 meter unit, was placed as close to the crest of the knoll as the landowner would permit. The unit was excavated to a depth of 60 cm.; the first 20 cm. was not screened because of the disturbed condition of the surface. Rodent disturbance was evident in all levels.

## Cultural Materials

No features or artifact concentrations were encountered. Lithic artifacts recovered include one thick biface, one thin biface basal fragment and one thin biface distal fragment.

Utilized flakes or chips consist of four tertiary Group I, one tertiary Group II, three tertiary Group IV, and one secondary Group I.

The thick biface is subtriangular in outline with a pointed end, a peaked dorsal surface and a slightly convex ventral side. Length: 7.7 cm. Width: 4.5 cm. Thickness: 1.8 cm.

#### Faunal Remains

None were found in this unit.

#### Shell Remains

Less mussel shell was recovered from this unit than the previously described two.

#### UNIT 4 (N1000/W990)

Unit 4 was excavated as a 1 x 2 meter unit to the 60-80 cm. level. The unit was then reduced to 1 x 1 meter. The first 20 cm. was unscreened. Rodent and root disturbance was high in all levels, contributing to the evident mixing of the cultural materials.

#### Cultural Material

No features or artifact concentrations were encountered. Lithic artifacts include three thick biface basal fragments and one tertiary Group III utilized flake. All three thick biface fragments were subrectangular in shape with rounded bases, sinuous edges and steep sloping sides. Other cultural materials recovered are listed in Appendix I.



#### Faunal Remains

No faunal remains were recovered from this unit.

#### Shell Remains

Mussel shell was present in quantities similar to Unit 3.

#### UNIT 5 (N1012/W1000)

Unit 5 was excavated to expose a large chunk of burned clay seen in the north wall of Unit 1. The first 20 cm. of matrix was discarded; the next 60 cm. was removed in increments of 20 cm. The burned clay was exposed; no cultural materials were found in direct association.

#### Cultural Material

No artifact concentrations or features were exposed in Unit 5. Lithic artifacts recovered are one thin biface basal fragment and two tertiary Group I, one tertiary Group II, two secondary Group I and one secondary Group IV utilized flakes.

The thin biface fragment is subrectangular and has basal thinning along the flat base.

#### Faunal Remains

No faunal remains were recovered from Unit 5.

#### Shell Remains

Freshwater mussel shell was recovered in quantities similar to Units 3 and 4.

## UNIT 6 (N969/W999)

This 1 x 1 meter unit was situated downslope from the other units to determine the extent of cultural debris along the slope. Cultural material occurred in the three 20 cm. levels excavated. Rodent disturbance contributed to the apparent mixing of materials.

## Cultural Material

The only lithic artifact recovered is one thick biface fragment, broken at both ends. The specimen is crudely shaped and has sinuous edges with steep sloping sides. Other cultural material is listed in Appendix I.

## Faunal Remains

No faunal material was recovered from Unit 6.

## Shell Remains

The frequency of shell in this unit was considerably less than in the other units.

## STATISTICAL ANALYSIS\*

All artifacts and culturally introduced material were computer coded according to level, unit and site. The excavated level was selected as the primary unit of analysis

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\*In addition, see Appendix II for a discussion of the limitations of chi square as a determinant of diminishing returns.

because of the low number of diagnostic artifacts recovered. Ceramics, all lithic categories, silicious wood and sandstone fragments, mussel shell hinges and snails by species were coded as frequencies; burned rock, burned clay, snails, mussel shell, calcium carbonate concretions and gravels were analyzed by weight (grams).

To compensate for the differences in horizontal and vertical dimensions of the arbitrary levels a Fortran program was employed to convert all frequencies and weights to a density equivalent to a one  $m^2$  unit and a 10 cm. level. However, any comparisons using sites as the unit of analysis should take into consideration the total volume excavated at each site. The four units and 22 levels at LK114 total 3.52  $m^3$ , four units and 11 levels at LK116 equal 5.2  $m^3$ , and six units and 20 levels at LK228 equal 6.8  $m^3$  volumetrically.

The mixed deposits and lack of discernable features or living surfaces which characterizes these sites effectively eliminated the potential for meaningful analyses of intrasite variability. In addition, the small sample size gained from all three sites cannot be considered as statistically adequate. The results of the statistical analyses are presented as a summary of the salient characteristics of these sites (Appendix I).

Descriptive statistics and a preliminary principal components analysis of the primary data were used to select

pertinent variables for further analysis. Ceramics, dart points, hammerstones and abraders were eliminated because of their low frequency. The weights of mussel shell and snail were selected as more representative of the total population than are frequencies of identifiable species or portions of the shell. The obvious high correlation between these interrelated variables (frequencies and weights of the same category) created a redundancy acceptable in factor analysis but of no utility in further analysis.

The fifth principal factor derived by the preliminary analysis was bipolar with high loadings for calcium carbonate concretions (-.5941) and mussel shell (.8104). This correlation was determined to be artificially derived from the presence of  $\text{CaCo}_3$  at LK114 and its virtual absence at LK116, the source of most of the mussel shell, and biased by collection techniques (see Methodology section). Calcium carbonates are considered to be a natural phenomenon and were removed from further analysis. Gravels were retained, although most are naturally occurring, because collection techniques were similar. Gravels are a convenient identifier of 41LK114.

Factor analyses (orthogonal) were performed on both the primary data and the computed densities. Five factors with eigenvalues greater than 1., accounting for 73 percent

of the variance, were produced; a sixth factor (eigenvalue .96) accounted for an additional 6.9 percent. One expected correlation, between burned rock and burned clay, was not evident; this was attributed to the orthogonal solution. The factor analyses were rerun using an oblique rotation. Once again, five factors were derived which accounted for 100 percent of the variance.

Given the susceptibility of factor analysis to manipulation through selection of variables and factoring method, slight variation in the ordering of factors is to be expected. The recurrent correlations are summarized as a composite of the results of each method. One primary factor carried high loadings for secondary and tertiary flakes, chips, petrified wood and burned rock. These categories, with the exception of petrified wood which is absent at LK116, are present at all three sites and can be considered as a generalized pattern of co-occurrence. Snails and burned clay are highly correlated and are often accompanied by a moderate loading for utilized flakes. This relationship is probably the result of snail exploitation of human occupation rather than the reverse.

Cores, primary flakes and gravels are aligned on the same factor. This could be designated as the "LK 114" factor for the site where the preponderance of these artifacts was recovered. Bone and mussel shell tend to be

unique to their separate factors; an occasional addition of bifaces to the mussel shell factor is not confirmed by the primary data and may result from the conversion of a low frequency (bifaces) to a density factor. The communality of the variable biface is low, implying its contribution to common variance is negligible.

The oblique structure matrix seems to most truly reflect the patterning of the data. In this solution the lithic categories load on two factors as in the orthogonal solution, separating cores and primary flakes from the remainder of the debitage; burned clay and snails replicate their previous association and the correlation between burned rock and burned clay seen at LK114 is indicated by similar moderate loadings on the first factor.

The factor analyses served to delineate patterning in the artifact assemblages. Discriminant function analysis was employed to examine the intersite variability. A step-wise discriminant function (using Rao's V as the criterion) of both primary and transformed data determined the major differences in the composition of assemblages recovered from the three sites. One option of discriminant function is to determine the cohesiveness of the *a priori* group, in this case, the site. In other words, are they distinct entities or do they share common characteristics to the extent that one site is indistinguishable from the other? Each of the

three sites yielded an artifact assemblage unique enough to separate them in statistical space, implying perhaps functional or temporal discreteness.

Site 41LK114 is characterized by the heavy concentrations of burned rock, burned clay, the presence of cores, primary flakes, petrified wood and the only hammerstone recovered in the excavations.

41LK116 is distinguished from LK114 and LK228 by the relative absence of burned rock, burned clay, bone (possibly a function of differential preservation), sandstone and the presence of mussel shell in abundance.

41LK228 differs from LK114 in the absence of cores, primary flakes and petrified wood and in the increased quantity of burned clay and the co-occurring snails. Ten of the fifteen bifaces or biface fragments were recovered here. The snail species *Rabdoda* predominates at LK228; *Polygyra* are more evenly distributed between the three sites, perhaps indicative of differing habitats.

A literal interpretation of the results of these two statistical analyses would imply that 41LK116 was primarily a mussel collecting locale, as could be presumed from its location close to the river. 41LK114 and LK228 reflect more characteristics of multi-purpose encampments. The emphasis on initial lithic production seen at 41LK114 is plausible in view of the proximity to raw materials. 41LK228 lacks

specialized attributes and can not be easily categorized.

The characteristics which set these sites apart statistically are only functionally interpreted. The paucity of time-diagnostic artifacts recovered precludes any inferences about seasonal exploitation or contemporaneous occupation.

#### SUMMARY AND CONCLUSIONS

During September and October of 1979, archeological excavations were carried out at sites 41LK114, 41LK116 and 41LK228, prior to the construction of the Three Rivers Flood Protection Project.

These three sites have all been subjected to surface and shallow subsurface disturbance by plowing, and all showed evidence of considerable post-depositional bioturbation. Excavation in each case confirmed that substantial mixing of the archeological deposits had resulted from this biological activity. At 41LK116, the difficulties were compounded by the soil matrix, a Vertisol with extreme shrink/swell characteristics. Agricultural terracing at 41LK228 had further dispersed the upper zones.

All three sites are located close to water sources. Sites 41LK114 and 41LK228, however, are topographically more suitable for extended occupation. Situated on high terrace knolls, these locales are less susceptible to flooding.



41LK116, located on the floodplain, would have been frequently inundated; the Vertisol soils here would retain moisture after floods or rains for longer periods than the well drained soils at 41LK114 and LK228.

Few diagnostic artifacts were recovered during the current series of excavations, precluding time isolation of the occupations of these sites. The *Dart*, *Bulverde* and *Tortuga* dart points recovered at 41LK114 imply that this site was occupied at least during the Late Archaic Period. The five small bone-tempered ceramics found in the 0-20 cm. level at 41LK116 are characteristic of the Late Prehistoric Period. Although no time-diagnostic artifacts were recovered at 41LK228 during the course of this excavation, a side-notched (*Ensor*) dart point, assignable to the Late Archaic, was collected from the surface during the 1979 survey (Dibble 1979).

Given the mixed strata, the lack of cultural features or structural integrity, and the paucity of diagnostic artifacts, no attempt has been made to quantitatively interpret intrasite variability. The archeological assemblages can best be interpreted by observing the generalized intersite patterns of co-occurrence and variability.

The primary component of the cultural material recovered from 41LK116 is mussel shell. Burned rock and burned clay occur here in significantly smaller quantities than at the other sites. The topographic situation is more conducive

to short-term occupation. The artifact assemblage, the site location in the floodplain, and the proximity to the Frio River all imply that 41LK116 was utilized primarily as a mussel collecting station.

Sites 41LK114 and LK228 share many characteristics such as their topographic location on high well-drained terrace knolls. Burned rock, burned clay, lithic debitage and mussel shell are all included in the cultural materials recovered from both sites. Site 41LK114, however, is distinguished by the numerous cores and primary flakes recovered; this site is close to a lithic resource, the outcrops of the Catahoula Formation.

A functional interpretation of site 41LK228 is impeded by the lack of specialized attributes. Similarities to the 41LK114 cultural materials lie primarily in the quantities of burned rock and mussel shell; burned clay is more abundant at LK228. However, the units excavated at 41LK228 cannot be considered a representative sample of the archeological content. The crest of the knoll, the area of highest surface artifact density, was also the least disturbed by agricultural modifications. This area of the site, which held the most promise for intact archeological deposits, was not sampled.

On the basis of subsurface examinations of sites 41LK114, LK116, and LK228, no further work is warranted. However, due to the access restrictions at 41LK228, the full

potential of this site was not explored. Care should be exercised during construction of the levee in order to avoid damage to the cultural deposits still extant in the crest of this knoll.

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## ACKNOWLEDGMENTS

Appreciation is extended to staff members of the Texas Archeological Survey, Gene P. Davis, Molly G. Godwin and Mary Jane McReynolds, for their participation in the field work at the Three Rivers Flood Protection Project, and to David S. Dibble. As principal investigator, Dr. Dibble provided guidance during the field investigations and handled all administrative matters.

Special thanks to the following people: Solveig A. Turpin who handled the statistical analysis and the editing of the report; Margaret J. Kluge, who assisted in the editing and final production of the manuscript; Linda Nance, who typed it; Jack Grieder, who prepared the photographic plates; and Bruce Wilson, who drafted the maps. The efforts of all these people during the production of this report are greatly appreciated.

APPENDIX I. Artifact Categories Tabulated  
by Site, Unit and Level



# APPENDIX I. Artifacts Categories Listed by Site, Unit and Level

41LK114																						
Unit 4																						
Level 1																						
ceramics	dart points	bifaces	cores	modified flakes	primary flakes	secondary flakes	tertiary flakes	chips	mussel hinges	mussel shell (gr.)	rabdoda	polygrya	snails (gr.)	silicious wood	bone	gravel (gr.)	sandstone	hammerstone	abrader	burned rock (gr.)	burned clay (gr.)	
0	3	2	7	17	11	76	163	169	44	68.6	226	82	589.9	37	10	1569.4	3	0	0	24143.0	2709.2	
	1		1	5	1	8	16	24	11	5.8	2	3	5.5			104.1	1			2091.4	242.2	
2				4	1	13	29	30	8	9.1	12	8	27.3	4		137.5				2550.5	55.3	
3	1		1		1	8	19	26	11	24.6	37	15	112.5	5		140.0				2555.6	371.5	
4	2		1	1	5	8	21	13	2	2.7	40	13	116.3	6	4	135.5	1			2290.0	297.0	
5			4	1	2	10	22	34	5	8.4	34	17	94.7	4	1	179.9				3099.2	414.1	
6				3	1	16	31	24		1.1	50	16	125.6	14		89.5				6379.1	632.4	
7	1			2		9	15	13	6	13.6	34	9	83.3	3	5	87.3	1			3707.4	556.7	
8				1		3	4		1	0.1	10	1	19.0			344.2				1000.3	82.4	
9							4	3		0.9	4		4.9			166.2				263.1	44.1	
10						1	2	2		2.3	3		0.8	1		185.2				206.4	13.5	
Unit 5																						
Level 1																						
1	0	0	3	2	1	39	87	15	7	83.5	56	15	156.5	6	8	539.7	0	0	0	11441.8	1450.8	
2				1		6	9	1	1	3.2		3	0.7		1	46.6				1421.8	79.2	
3					1		4	2	3	0.3	1	1	0.4	3		25.6				1174.2	81.8	
4						7	19	3		0.2	5	2	11.2	2	6	116.4				1586.0	151.0	
5						6	17	4	1	0.2			2.7		1	90.4				1253.6	52.6	
6			1			2	10		1	14.1	5	1	12.6	1		21.7				1198.9	174.3	
7						7	13	3		10.6	12	2	36.9			82.2				1864.9	235.9	
			2	1		7	15	2	1	54.9	33	6	92.0			156.8				2942.4	676.0	
Unit 6																						
Level 1																						
1	0	0	5	1	6	25	50	33	0	0	0	0	0	21	7	19363.3	10	0	0	6219.9	348.2	
2			1	1	1	6	12	4								4646.7				4296.0	149.7	
3			3		3	10	15	17						8		7396.9				889.5	105.0	
			1		2	9	23	12						13	7	7319.7	10			1034.4	93.5	
Unit 7																						
Level 1																						
1	0	0	1	0	0	37	27	11	0	0	0	0	0	11	0	99.4	0	1	0	5619.1	324.6	
2						16	16	6						7		68.6				2449.0	40.7	
			1			21	11	5						4		30.8	1			3170.1	283.9	
SITE TOTAL																						
0	3	2	16	20	18	177	327	228	51	152.1	282	97	746.4	75	25	21571.8	13	1	0	47423.8	4832.8	

APPENDIX I. Continued

	ceramics	dart points	bifaces	cores	modified flakes	primary flakes	secondary flakes	tertiary flakes	chips	mussel hinges	mussel shell (gr.)	rabdode	polygrya	snails (gr.)	silicious wood	bone	gravel (gr.)	sandstone	hammerstone	abraded	burned rock (gr.)	burned clay (gr.)
41LK116																						
Unit 1	0	0	2	0	2	0	50	69	26	374	796.0	45	13	109.8	0	0	0	0	0	0	678.2	231.9
Level 1	1	1	1		1		26	47	17	148	161.9										251.5	116.4
2		1	1		1		24	22	9	226	634.1	45	13	109.8							426.7	115.5
Unit 2	0	0	0	5	3	1	16	29	17	190	390.6	61	63	126.5	0	0	77.8	1	0	0	789.1	790.9
Level 1	1		1	1	3		13	20	16	114	127.5	11	33	20.8			77.8	1			482.0	242.5
2				4		1	1	6		67	222.1	40	25	76.2							186.1	468.7
3							2	3	1	9	41.0	10	5	29.5							121.0	79.7
Unit 3	5	0	1	1	6	1	13	49	32	13	16.0	4	3	0.8	2	0	4.3	2	0	0	309.8	142.3
Level 1	5		1	1	5		10	40	28	11	12.5	1	2	0.1	2		4.3	1			263.1	90.9
2					1	1	3	9	4	2	3.5	3	1	0.7				1			46.7	51.4
Unit 4	0	0	2	1	3	0	30	67	22	36	63.7	39	10	116.9	0	0	3.6	0	0	0	551.3	263.9
Level 1		1			2		9	30	5	14	8.3	4	3	6.7							244.9	35.0
2			1	1	1		15	28	17	6	8.2	6	3	18.0							204.5	68.2
3		1					6	4	16	16	47.2	27	4	87.4							101.9	160.7
4								5				2		4.8			3.6					
SITE TOTAL	5	0	4	7	14	2	109	214	97	613	1266.3	149	89	354.0	2	0	85.7	3	0	0	2328.4	1429.0

APPENDIX I. Continued

	ceramics	dart points	bifaces	cores	modified flakes	primary flakes	secondary flakes	tertiary flakes	chips	mussel hinges	mussel shell (gr.)	radde	polygra	snails (gr.)	silicious wood	bone	gravel (gr.)	sandstone	hammerstone	sbrader	burned rock (gr.)	burned clay (gr.)
41LK228																						
Unit 1	0	0	2	0	8	1	31	118	55	39	61.5	160	16	442.5	4	16	224.9	4	0	2	2249.0	1733.4
Level 1					1		9	55	24	16	19.9	6	6	15.0	3	16	51.2				1193.4	637.5
2			1				2	23	10	7	11.2	21	2	56.3	1		47.4		1		382.2	508.3
3					6	1	14	31	21	14	22.3	90	6	257.7			60.3	4			538.6	506.8
4			1		1		6	9		2	8.1	43	2	113.5			66.0		1		134.8	80.8
Unit 2	0	0	0	0	11	0	47	196	88	40	80.7	114	44	304.0	5	8	230.6	3	0	0	1335.2	1005.3
Level 1					4		15	56	35	7	14.5	2	5	6.5	4	4	31.5				577.4	197.9
2					5		20	58	38	10	13.7	20	14	46.9		4	50.6	3			81.5	282.1
3							6	39	8	7	22.5	29	14	85.8	1		58.4				423.2	343.5
4					1		4	29	6	15	24.9	47	9	125.9			62.4				178.6	117.6
5					1		2	14	1	1	5.1	16	2	38.9			27.7				74.5	64.2
Unit 3	0	0	3	1	9	0	43	116	82	28	40.8	131	25	358.3	1	1	106.3	13	0	0	1087.1	1073.3
Level 2			1		5		22	50	39	16	24.4	24	11	78.4			30.2	9			366.5	520.4
3			2	1	2		15	33	40	9	14.3	66	8	179.6	1	1	57.0	4			365.5	255.6
4					2		6	33	3	3	2.1	41	6	100.3			19.1				355.1	297.3
Unit 4	0	0	3	0	1	0	2	24	0	21	48.5	71	25	84.4	1	0	151.0	0	0	0	1044.1	459.0
Level 2			3				2	11		6	8.7	6		19.9			46.9				248.9	163.3
3					1			6		13	30.5	59	24	39.1			55.7				733.7	271.0
4								7		2	9.3	6	1	25.4	1		48.4				61.5	24.7
Unit 5	0	0	1	1	6	0	13	37	11	9	46.4	95	5	261.0	0	0	42.7	2	0	0	670.4	1915.6
Level 2							2	9	3	4	12.7	11		30.8							267.5	377.6
3			1				3	11		3	20.0	34	5	96.8			21.5				345.4	458.4
4					1	6	8	17	8	2	13.7	50		133.4			21.2	2			57.5	1079.6
Unit 6	0	0	1	0	0	0	8	22	4	4	4.4	9	6	21.0	0	0	15.9	0	0	0	152.8	183.5
Level 2							4	15	4	3	2.0	5	2	5.2			15.9				78.1	119.4
3			1				4	7		1	2.4	4	4	15.8							74.7	64.1
SITE TOTAL	0	0	10	2	35	1	144	513	240	141	282.3	580	121	1471.2	11	25	771.4	22	0	2	6538.6	6370.1

APPENDIX II. A Comment on the Use of  
Chi Square in Diminishing  
Returns Analysis

*Solveig A. Turpin*

A COMMENT ON THE USE OF CHI SQUARE  
IN DIMINISHING RETURNS ANALYSIS

The current emphasis on on-going statistical tests for diminishing returns in archeological excavation is intended to provide the field archeologist with a replicable, definitive guide for determining redundancy in artifact recovery and to provide a numerical justification for termination or continuation of excavation. In addition, objectivity supposedly supplants, or augments, subjective judgmental decisions of the archeologist.

Although no statistical test has been specified, chi square has been used as the determinant of diminishing returns. Presumably, chi square was chosen because it is nonparametric and is easy to perform on a hand calculator. Our experience in the analysis of the Three Rivers Flood Protection Project excavations has indicated that chi square does not achieve the objectives outlined above.

Chi square is a test of independence, or of association, with no predictive power and no causality implied. Only the significance of the deviation of the observed from the expected values is determined. The direction of this relationship is not indicated.

By extension, this implies that the validity of the observed and expected frequencies is of primary importance. Chi square may be applied to one sample or to many - in the

case of archeological investigations we may consider the sample (or the comparative entities) as levels in a unit, one level in multiple units, multiple levels in multiple units, or unit versus unit. We could even extend this to include units or levels in one site compared to another site, or the entire recovery from one site versus another. However, let us restrict ourselves to the most logical choice - one or more levels compared to equivalent levels in one other, or all other, units in one site. This we will then consider the analytical unit.

The preferred comparative classes of artifacts have been lithic. Because chi square requires an expected frequency greater than five, time-diagnostic projectile points and other rare or unusual items are excluded from consideration. Another assumption of chi square, that only frequencies may be compared, excludes those cultural remains catalogued by weight or by percentages. This is compounded at Three Rivers by the differing dimensions of units and levels excavated in which the observed recovery may have been removed from  $.10 \text{ m}^3$  to  $.40 \text{ m}^3$  volumetrically. Conversion of these frequencies to densities reduces the expected to less than five for most classes of artifacts. In the limited assemblage recovered from Three Rivers, the categories that fulfill these assumptions are secondary and tertiary flakes, chips and mussel hinges. In the following paragraphs, we will liberally interpret the

calculated densities as frequency per 1 x 1 meter, 10 cm. level.

The consideration of comparative classes now broadens our options once more to include a choice of one or more artifact classes within a level or a unit. A selection must be made from this array of numbers or the objective of ease of computation is defeated. In essence then, the choice of comparative units and classes becomes a subjective, judgmental decision on the part of the field archeologist.

Let us, however, assume the most appropriate choice of analytical units and comparative classes has been made and proceed to a hypothetical situation in which chi square could fail to detect redundancy. A two component site is being excavated; the first two equivalent units are typical of Component A, the third reflects the assemblage of Component B. If we excavate a fourth unit of Component A, the chi square comparisons of Unit 3 and Unit 4, or of all four units simultaneously, could indicate new material is being recovered. However, if Unit 3 is tested against Units 1 and 2, redundancy would be indicated.

A more tangible example can be taken from the enclosed data from 41LK116. The chi squares calculated for all four units using frequencies of secondary and tertiary flakes and mussel hinges are all significant at the .05 level. The chi

square computed comparing tertiary flakes from the first two units indicates redundancy; the addition of the third unit excavated produces a significant chi square. "Diminishing returns" is literally the reason for this significance; we are recovering significantly less material from this unit. By this logic, excavating beyond the perimeter of the site could be consistent with producing a significant chi square as long as we keep our expected frequency above five.

In the few cases where densities met this assumption, the computed chi square was approximately half of the statistic derived from comparison of frequencies. As our degrees of freedom are dependent on the number of units and levels, this lowered chi square affects the significance drastically.

The sites excavated at Three Rivers are not ideal for a test of chi square as an indicator of diminishing returns. We cannot compare levels overlying features or test for discrete stratigraphic levels or components. However, the utility of this test supposedly lies in its objective capabilities. What has resulted from the analysis of Three Rivers is that the significance of chi square depends on subjective decisions of the archeologist - the choice of analytical units and comparative classes, and the interpretation of causality. Furthermore, without some explicit guidelines or detailed reporting of the choices made, the replicability of the test is questionable. By manipulation of classes and units, almost any



desired "significance" can be gained through interpretation of the results.